

Diabetes Mellitus and Exercise

- ❖ A minimum of 30 minutes of moderate-intensity aerobic physical activity 5 days per week, or vigorous-intensity aerobic physical activity for 20 minutes 3 times per week is recommended for healthy adults aged 18 to 65. Physicians are encouraged to modify exercise guidelines to meet individual patient's needs according to level of activity tolerated, comorbid conditions which may limit vigorous physical activity, or diabetes complications (retinopathy, neuropathy, amputation, etc.) which may limit physical activity.
- ❖ The goal of physical activity/exercise is to maintain near-normal blood glucose and lipid levels to prevent microvascular, macrovascular, and neural complications.
- ❖ Exercise is Medicine! It can lower blood pressure, decrease blood glucose, reduce weight, improve cholesterol, enhance sleep, maintain bone and heart health, and decrease the risk of cancer.
- ❖ Exercise programs should be individualized to maximize benefit and minimize risk.
- ❖ The ADA recommends that vigorous activity be avoided in the presence of hyperglycemia with ketosis. However, a patient with type 2 diabetes in the postprandial state who is well hydrated and non-ketotic should not have exercise postponed based solely on hyperglycemia.
- ❖ Depending on the level and duration, one occasion of aerobic exercise can increase insulin sensitivity for 24 to 72 hours.
- ❖ To improve glycemic control, assist with weight maintenance, and reduce CVD risk, at least 150 min/week (30 min/day – 5 days/week) of moderate intensity aerobic physical activity (40-70 percent of Vo_2) is recommended. Individuals with type 2 diabetes should strive to achieve a minimum cumulative total of 1000 kcal/week from physical activities.
- ❖ Examination of the feet, with shoes and socks off, should be done on a daily basis by the patient and at each clinic visit by the physician.
- ❖ Resistance training preserves muscle mass, improves balance, increases functional capacity, increases metabolic rate, decreases adiposity, and increases insulin sensitivity at about the same rate as aerobic exercise.
- ❖ The benefit of exercise in lowering the hemoglobin A1C level is independent of associated weight loss.
- ❖ In 2006, 9.3 percent of BRFSS respondents with diabetes reported having no leisure time physical activity.

According to the Surgeon General, physical activity can be described as bodily movement produced by the contraction of skeletal muscle that requires energy expenditure in excess of resting energy expenditure. Exercise has been defined as physical activity and/or movement that is planned and structured with the intention to keep a person fit and healthy. Current opinion is that regular physical activity is an important therapeutic tool for people with diabetes. However, the benefits and risks for each individual need to be identified and exercise programs need to be individualized.

Prior to beginning an exercise program more vigorous than brisk walking, people with diabetes should be evaluated for the presence of conditions likely to increase CVD risk factors or predisposition to injury, such as uncontrolled hypertension, severe autonomic or peripheral neuropathy, pre-proliferative or proliferative retinopathy, or macular edema. The patient's age and previous physical activity level should be evaluated.

Muscular-strengthening training (strengthening of muscles using equipment such as free weight, resistance bands, and weight machines) has recently been added to the activity plan for patients with diabetes based on a Canadian study conducted by Sigal et al. Study findings noted a 0.6 percent drop in hemoglobin A1C levels with both aerobic and resistance activity individually, but by combining both activities, a 1 percent absolute reduction in A1C readings was appreciated. This translates into about a 15 to 20 percent reduction in major cardiovascular events, and a 37 percent decrease in microvascular complications.

What are physical activity recommendations for people with diabetes?

Based on guidelines from the American College of Sports Medicine and American Heart Association, basic exercise recommendations for adults over age 65 (or adults 50 to 64 with chronic conditions such as arthritis) with diabetes are as follows:

1. Do moderate-intense aerobic activity 30 minutes a day, 5 or more days a week, or
2. Do vigorous-intensity aerobic exercise 20 minutes a day, 3 or more days a week, and
3. Do 8 to 10 strength-training exercises, 10 to 15 repetitions of each exercise twice to three times per week, and
4. If patient is at risk of falling, perform balance exercises, and
5. Have a physical activity plan.

Both aerobic and muscle-strengthening activities are critical for healthy aging. **Moderate-intensity aerobic exercise** means working hard at about level three intensity on a scale of ten. The patient should still be able to carry on a conversation during this physical activity and start to break a sweat.

Older adults or adults with chronic conditions should develop an **activity plan** with a health professional to manage risks and take therapeutic needs into account. This will maximize the benefits of physical activity and ensure safety.

It is recommended that patients who have an impaired glucose tolerance follow a program that includes a healthy diet with weight control and at least 150 min/week of moderate to vigorous physical activity.

Evaluating risk and prescribing exercise to minimize risk.

Coronary Artery Disease

All patients with diabetes participating in aerobic exercise should undergo a stress test to assess maximal heart rate, to assist in setting targets for maximum exercise intensity, to determine functional capacity, and to assess prognosis. Currently, there is no clinical evidence to guide practitioners on the need for stress testing prior to resistance training.

In patients who are sedentary, a graded exercise test with EKG monitoring should be considered before prescribing a physical activity greater than the energy needs of activities of daily living or more intense than brisk walking, or if the patient's ten year risk of having a coronary event is greater than 10 percent. The free UKPDS Risk Engine located at <http://www.dtu.ox.ac.uk/index.php?maindoc=/riskengine/> can assist in determining a patient's risk factor for non-fatal and fatal coronary heart disease, fatal coronary heart disease, non-fatal and fatal stroke, and fatal stroke based on age, gender, ethnicity, duration of diabetes, smoking status, hemoglobin A1C level, systolic blood pressure, total cholesterol, HDL cholesterol, and absence or presence of atrial fibrillation.

Patients who should have the graded exercise test with EKG monitoring include any patient over the age of 30 who is sedentary with a history of tobacco use, hypertension, dyslipidemia, proliferative/preproliferative retinopathy or nephropathy (including microalbuminuria) with diabetes greater than 10 years duration, and a greater than 10 percent risk of a coronary event. Others who should have this exam include all patients, regardless of age, exhibiting complications of known or suspected CAD, CVD, peripheral vascular disease, autonomic neuropathy, or advanced nephropathy with renal failure.

Patients with coronary artery disease should undergo an evaluation of exercise tolerance supervised by a physician with expertise in stress testing. Recommendations about appropriate exercise are dependent on the interpretation of exercise stress testing.

Peripheral Vascular Disease

If peripheral vascular disease (PVD) has been diagnosed through a history and physical exam, a referral for consultation should be made with a physician experienced in the care of patients with significant peripheral vascular disease to design an appropriate exercise program.

Retinopathy

Annual dilated retinal exam is sufficient to identify patients with diabetic retinopathy. Since retinopathy is a risk factor for coronary artery disease, patients with proliferative or preproliferative retinopathy who intend to pursue moderate or intense exercise programs should undergo a graded cardiac exercise test with EKG monitoring.

Progression of nonproliferative diabetic retinopathy and macular edema do not seem to be affected by either resistance or aerobic exercise. However, if proliferative or severe non-proliferative retinopathy exists, vigorous aerobic or resistance activities may be contraindicated due to the risk of triggering vitreous hemorrhage or retinal detachment (e.g. lifting heavy objects or any contact sport). People with diabetes need to be cautioned about engaging in activities that cause blood pressure to increase dramatically, such as head-down or jarring activities or those with arms overhead.

Nephropathy

Annual urine screening for proteinuria and microalbuminuria is sufficient to identify patients with nephropathy. Currently, there is no clinical evidence to suggest that vigorous exercise increases the rate of progression of diabetic nephropathy. In fact, some studies have shown that aerobic exercise actually decreased urine protein excretion. Additionally, it has been demonstrated that resistance training may have a beneficial affect on muscle mass, nutritional status, functional capacity, and glomerular filtration rate. Therefore, the American Diabetes Association feels that there is no need to restrict exercise in patients with diabetic nephropathy.

Due to the fact that microalbuminuria and proteinuria are risk factors associated with cardiovascular disease, sedentary patients with these findings should have a graded exercise test with EKG monitoring before beginning anything more rigorous than their normal activities of daily living.

Peripheral Neuropathy

Peripheral neuropathy can be detected by physical examination. Decreased pain sensation in the extremities can result in increased risk of skin breakdown, infection, and Charcot joint destruction. Signs of peripheral neuropathy include impairments in: deep tendon reflexes, vibratory sense, position sense, and sensation to touch. The main consideration with exercise in patients with peripheral neuropathy is the loss of protective sensation in the legs and feet that can lead to musculoskeletal injuries and infection. Reinforce with patients the need for proper footwear and to check their feet after exercise. Significant peripheral neuropathy is a contraindication to weight bearing exercise. Examples of non-weight bearing activities include swimming, bicycling, rowing, and arm exercises.

Autonomic Neuropathy

History and physical examination can detect autonomic neuropathy. Autonomic neuropathy can increase the risk of exercise-induced injury by decreasing cardiac responsiveness to exercise. Symptoms of autonomic neuropathy include: gastrointestinal symptoms, urinary system symptoms, and defective thermoregulatory capacity. Signs of autonomic neuropathy include abnormalities of skin color and abnormalities of body temperature. Autonomic neuropathy may limit exercise capacity and may increase a patient's risk of a cardiovascular complication during exercise. Patients may have defective thermoregulatory capacities, thus they should be advised to avoid exercising in extreme temperatures and be attentive to their hydration status. Patients may be predisposed to hypotensive or hypertensive episodes following exercise, thus patients should be encouraged to participate in lower intensity exercise to avoid dramatic change in heart rate and blood pressure. An active cool-down is important in preventing a post-exercise hypotensive response. Signs of cardiac autonomic neuropathy include resting tachycardia (> 100 beats per minute) and orthostasis (> 20 mmHg drop in systolic pressure on standing), thereby making traditional exercise prescriptions based on heart rate inaccurate. Cardiac autonomic neuropathy is associated with sudden death and silent myocardial ischemia. The Rate of Perceived Exertion (RPE) scale or %Vo₂ Max can be used to determine exercise intensity. Patients with cardiac autonomic neuropathy should be evaluated by a cardiologist prior to initiating an exercise program. In fact, some advocate thallium scintigraphy for use in screening patients with this condition.

General recommendations about exercise programs.

Program intensity

Physical activity of low to moderate levels for patients with type 2 diabetes will minimize risks and maximize health benefits. Low to moderate intensity level exercise programs may be easier for patients to follow and maintain.

Pre-exercise preparation

- ❖ Exercise should be avoided at time of peak insulin activity.
- ❖ To prevent increased insulin absorption, injections should be administered in body areas not involved with activity, e.g. abdomen.
- ❖ Patients should check their blood glucose levels before and after exercise, as well as several hours following completion of exercise until they know the effect of physical activity on their blood glucose levels.
- ❖ In type 1 diabetes, vigorous activity should be avoided in the presence of ketosis and caution should be used with any physical activity/exercise for blood glucose levels > 300 mg/dl even if no ketosis is present. However, in type 2 diabetes, if the blood glucose is greater than 300 mg/dl without ketosis and the patient feels well and is well hydrated, exercise need not be postponed based on hyperglycemia.

Pre-exercise carbohydrate should definitely be taken to avoid hypoglycemia if pre-exercise glucose levels are < 100 mg/dl and the patient is taking insulin or a secretagogue, or the dosage of medication reduced before sessions of physical activity. However, patients who are not taking either insulin or secretagogues but are controlling their blood glucose levels with diet, metformin, α -glucosidase inhibitors, and/or thiazolidinediones usually will not need additional carbohydrates.

- ❖ Carbohydrate-based foods should be readily available during and after exercise.
- ❖ Proper warm-up and cool down period will decrease injuries.
- ❖ Diabetic ID bracelet or shoe tag should be worn.

Hydration

- ❖ Adequate hydration is necessary to maintain blood glucose levels and assure optimal cardiovascular function.
- ❖ Exercise in heat requires vigilant attention to hydration status.
- ❖ Pre-exercise hydration is particularly useful. For events lasting up to one hour, plain water is best. If activity is over one hour, fluids containing a 6 to 8 percent carbohydrate solution are best.

Foot care

- ❖ People with diabetes should be encouraged to take precautions to avoid injury to their feet.
- ❖ Silica gel or air mid-soles decrease impact.
- ❖ Polyester and cotton-polyester blend socks may be helpful in preventing blisters.
- ❖ Patients should be encouraged to change their socks before and after exercise.
- ❖ Properly fitting footwear is very important.
- ❖ Patients should know to examine their feet closely for blisters before and after exercise.

Post-exercise routine

- ❖ Patients should monitor their blood glucose levels after exercise in order to learn their metabolic response to different exercise conditions.
- ❖ Post exercise hypoglycemia may occur up to 30 hours later, especially after prolonged or vigorous exercise.

References:

1. Albright, A., Ehrman, J., Gordon, P., Visich, P., Keteyian, S. (2003). *Clinical Exercise Physiology: Human Kinetics*, Chapter 8, 129 -152.
2. American Association of Diabetes Educators. (2006). *The art and science of diabetes self-management education: A desk reference for healthcare professionals*. Chicago, IL: American Association of Diabetes Educators.
3. American Diabetes Association. (2007). Standards of medical care in diabetes. *Diabetes Care*, 30(Supplement 1), S4-S41.
4. Haskell, W., Lee, M., Pate, R., Powell, K., Blair, S., Franklin, B., Macera, C., Heath, G., Thompson, P., & Bauman, A. (2007). Physical activity and public health: Updated recommendation for adults. *Circulation*, 116, 1081-1093.
5. Exercise is Medicine: Physicians and Healthcare Professionals. (2007). Accessed December 18, 2007, from <http://www.exerciseismedicine.org/physicians.htm>.
6. Mitchell, T. (2007, November). Health Smart: Your Best Prescription. *USA Weekend*. Accessed December 18, 2007, from http://www.usaweekend.com/07_issues/071104/071104healthsmartprescription.html.
7. American College of Sports Medicine & American Heart Association. *Physical Activity and Public Health Guidelines: For adults over age 65 (or adults 50-64 with chronic conditions, such as arthritis)*. Accessed December 18, 2007, from http://www.acsm.org/AM/Template.cfm?Section=Home_Page&TEMPLATE=/CM/HTMLDisplay.cfm&CONTENTID=7764.
8. Sigal, R., Kenny, G., Wasserman, D., Castaneda-Sceppa, C., & White, R. (2006). American Diabetes Association consensus statement on physical activity/exercise and type 2 diabetes. *Diabetes Care*, 29(6), 1433-1438.
9. Sigal, R., Kenny, G., Wasserman, D., and Castaneda-Sceppa, C. (2005). Physical activity/exercise and type 2 diabetes. *Diabetes Spectrum*, 18(1), 88-101.
10. Sigal, R., Glen, K., Boulton, N., Wells, G., Prud'homme, D., Fortier, M., Reid, R., Tulloch, H., Coyle, D., Philips, P., Jennings, & Jaffey, J. (2007). Effects of aerobic training, resistance training, or both on glycemic control in type 2 diabetes. *Annals of Internal Medicine*, 147(6), 357-369.
11. South Dakota Department of Health. (2007). *The Health Behaviors of South Dakotans 2006*. Pierre, SD: Author. Available at: <http://doh.sd.gov/Statistics/default.aspx>.
12. Albright, A., Franz, M., Hornsby, G., Kriska, A., Marrero, D., Ullrich, I., & Verity, L. L. S. (2007). American College of Sports Medicine: Exercise and type 2 diabetes (position stand) *Med Sci Sports Exercise*, 1345-1360. Accessed December 18, 2007, from <http://www.acsm-msse.org/pt/pt-core/template-journal/msse/media/0700.pdf>.